Digital Clock

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Features and How to use them

Reset Button: After the reset button is released the time will become 00:00:00 in(hh:mm:ss) format. Though only 2 of these time states will be shown at a time.

Set Button: To set time set button should be pressed. The procedure to set time will be as follows:

> If current display mode is hh:mm then only these two units of time can be modified. To modify the seconds display mode has to be changed.
>
> When set button is pressed and released the 1st time, the left quantity of the current display can be altered. Pressing it for more than 2 second will start the fast increment. Fast increment is 4 units per second.
>
> When set button is pressed and released 2nd time the right quantity in the current display can be modified.
>
> Whrn set button is pressed and released the 3rd time the modified time is now set and to modify the time again the same cycle has to be repeated.
>
> **Note:** Mode button will not work if currently set button is not pressed for 3 times(multiple of 3).

Mode Button: There are 2 modes hh:mm and mm:ss. After the mode button is released the display will be toggled. Mode button will work given that till now set button is pressed in a multiple of 3 .

Increment Button: To increment by 1 unit press and release the button within 2 seconds. For fast increment keep the button pressed for more than 2 seconds and after 2 seconds increment of 4 units per second will keep happening until the button is released.

Blinking Dot: In both modes of display the dot blinking shows the passing of each second.

Major Design Decisions:

- I kept the refresh rate of each digit as 16ms i.e., each digit will be displayed for 4ms and will be displayed again after 12ms.
- I decided to keep only increment of time. I also kept the fast increment (4 units per second) option for the user.
- I also kept a reset button that will reset everything to 0. This is in case something is behaving weird then this button can be used to reset everything.
- I am checking every milli-second if a button was pressed.

VHDL Code Description

Inputs

- Clk_signal of 100MHz Frequency

- 4 buttons namely
    - Reset_button
    - Mode_button
    - Increment_button
    - Set_time_button

Outputs

- Cathode_out
- Anode_out
- LED_Blink – To blink the dot for displaying passing of each second. On for 0.5 second(with same refresh rate) and then off for 0.5 seconds.

Following signals were created

- ss : Integer type and stores the seconds unit of current time. Range 0 to 59.
- mm: Integer type and stores minutes unit of current time. Range 0 to 59
- count: Integer type to count pulses of clk_signal
- One_second_completed: BIT type and toggles after every second.
- hour : Integer type and stores the hour unit of current time. Range 0 to 23.
- Temp_blink: toggles every half second. Used for blinking of dot in display.
- ds1 : True means hh:mm is the current display else mm:ss display type.

- increase_hour : To check if slow increment or fast increment in hour unit of time.
- Increase_minute: To check if slow increment or fast increment in minute unit of time.
- Increase_second : To check if slow increment or fast increment in minute unit of time.
- Reset_pressed: to check if reset_button was pressed

- Set_pressed: to check if set button was pressed and how many times modulo 3.Hence total 3 states of this signal.
- LED_BCD: To give input of the digit to be displayed to the converter.
- 1ms_completed: toggles after each milli_second.
- 4ms_completed: Integer type with total 4 states [0,1,2,3]. Used for the refresh rate of every digit.
- Time_increment_button_pressed- Has 3 states [0,1,2]. 2 if fast increment has to be done and 1 if slow increment.
- Increment_pressed: Has 2 states. True if button is pressed when Set_Pressed signal has value 1 or 2. State is made 0 when button is released.

Following Processes namely:

- second_processing: Maintaned a counter to count pulses of the 100MHz clock signal. Maintained 4 types of clocks with frequencies 1Hz,2Hz,1000Hz and 250Hz
- Output_Clock: Changes the LED_BCD signal after every 4ms to display a digit.

- Buttons: To check if a button was pressed. Checking is done after every milli-second. Action for the button is completed after the button is released. The increment button actions is done in subsequent process.
- Fast_Increment: To check if fast increment ot slow increment has to be done. And chainging the states of the desired signals.
- Increment_time: To increment the time when the signals are changes in the above process.
- BCD_Converter: To convert the digit into 7 segment display.
- Digital: To add the regular second to the clock.